MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2018/2019

PME0016 – MECHANICS

(Foundation in Engineering)

24 OCTOBER 2018
9.00 a.m - 11.00 a.m
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This question paper consists of 5 printed pages excluding the cover page, physical constants and formula list.
2. Answer ALL five (5) questions. The distribution of the marks for each question is given.
3. Please write all your answers in the Answer Booklet provided.

QUESTION 1 (10 MARKS)

a) A 0.14 kg, 42.1 cm long uniform bar has a small 0.055 kg mass glued to its left end and a small 0.150 kg mass glued to the other end, as shown in **Figure Q1(a)**. The two small masses can each be treated as point masses. You want to balance this system horizontally on a fulcrum placed just under its center of gravity. How far from the left end should the fulcrum be placed? [2 marks]

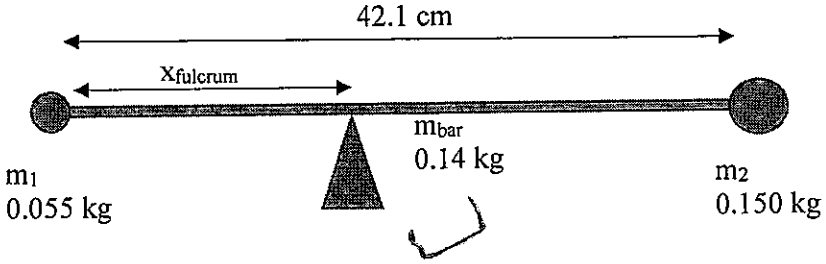

Figure Q1(a)

b) A uniform rod at Zoo Negara of 3.00 m long, weighing 255 N, is held in a horizontal position by two ropes at its ends as shown in **Figure Q1(b)**. The left rope makes an angle of 150° with the rod, and the right rope makes an angle θ with the horizontal. A 96 N monkey hangs motionless 0.50 m from the right end of the rod.

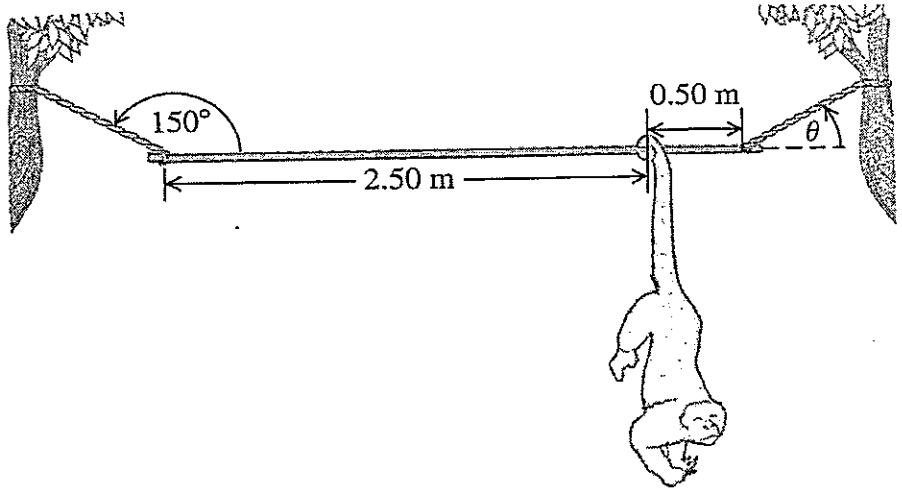

Figure Q1(b)

i) Draw a free-body diagram of the rod. [2 marks]

ii) Calculate the tensions in the two ropes and the angle θ. [6 marks]

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QUESTION 2 (10 MARKS)

a) Define "*Work*" and state the "*Work-Energy Theorem*".

[2 marks]

b) State the Principle of Conservation of Energy.

[1 mark]

c) A 1.0 kg plastic block is placed on a rough surface incline with the coefficient of kinetic friction, $\mu = 0.20$, which is initially released from rest. It is found that, the block, once it slides downwards, has a speed of v ms^{-1} at equilibrium position (x_o) of the spring (as shown in **Figure Q2(a)**). Then the block moves downwards and compresses the spring x m from the equilibrium position (x_o) before stopping momentarily and turning back (as denoted in **Figure Q2(b)**). Given the spring constant, $k = 300$ Nm^{-1} and $g = 9.81$ ms^{-2}, calculate:

i) the work done by the force of gravity when the object moves about *4.0 meters* from the initial position. (as shown in **Figure Q2(a)**)

ii) the work done by the friction force when the object moves about *4.0 meters* from the initial position. (as shown in **Figure Q2(a)**)

iii) speed v, at the equilibrium position x_o (as shown in **Figure Q2(a)**)

iv) compression distance x (as shown in **Figure Q2(b)**).

[7 marks]

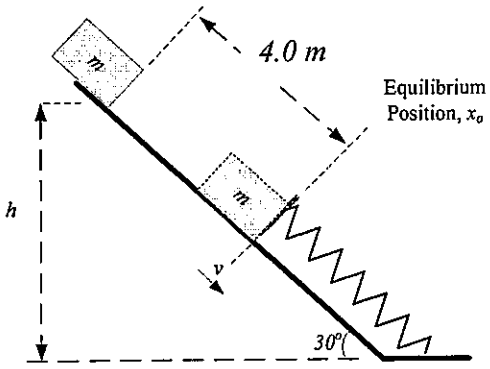

Figure Q2(a)

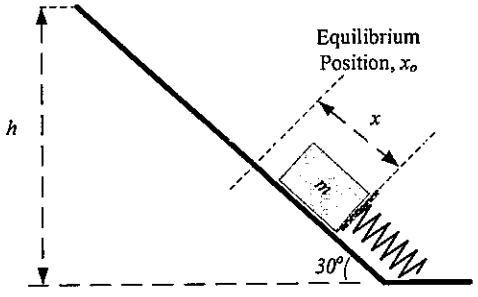

Figure Q2(b)

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QUESTION 3 (10 MARKS)

a) State the difference between tangential and radial acceleration for a point on a rotating body. [2 marks]

b) At t = 0 a grinding wheel has an angular velocity of 27.0 rad/s. It has a constant angular acceleration of 31.0 rad/s^2 until a circuit breaker trips at t = 2.50 s. From then on, it turns through 430 rad as it wheels to a stop at a constant angular acceleration.

i) Through what total angle did the wheel turn between t = 0 and the time it stopped? [2.5 marks]

ii) Determine the time it stopped. [3.5 marks]

iii) Calculate the acceleration as it slowed down. [2 marks]

QUESTION 4 (10 MARKS)

a) **Figure Q4(a)** shows graph of stress against strain of a typical steel wire. State briefly the points labelled with A, B and E. [3 marks]

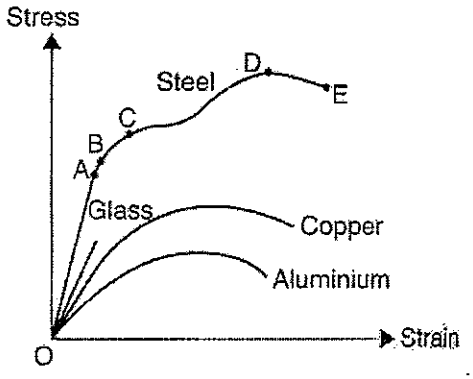

Figure Q4(a)

b) Define Young's modulus. [1 mark]

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c) **Figure Q4(b)** shows a light spring with a spring constant k of 300 Nm^{-1} resting vertically at the bottom of a large beaker of water (the density of water is 1000.0 kgm^{-3}). A 5.0 kg block of wood with density of 650.0 kgm^{-3} is connected to the spring and the block-spring system is allowed to reach static equilibrium.

i) Determine the volume of the wood block. [1 mark]

ii) Determine the buoyant force acting on the wood block. [1 mark]

iii) Calculate the net force on the spring. [1 mark]

iv) What is the elongation, x, of the spring? [1 mark]

v) State what happen (remain the same, increase or decrease) to the elongation of the spring in part (iv) if :

1. just the water is replaced by another liquid higher in density. [1 mark]

2. just the wood is replaced by another material of same mass but bigger in volume than the wood. [1 mark]

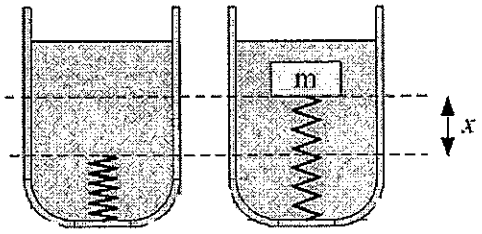

Figure Q4(b)

Continued...

QUESTION 5 (10 MARKS)

A 0.5 kg glider is attached to the end of an ideal spring with spring constant k = 455 N/m, as shown in **Figure 5(a)**. The glider undergoes Simple Harmonic Motion, where it begins to oscillate with an amplitude of 0.04 m. Obtain the:

a) angular frequency of the glider. [1.5 marks]

b) maximum speed of the glider. [1.5 marks]

c) speed of the glider when it is at x = -0.013 m from its equilibrium position. [1.5 marks]

d) magnitude of the maximum acceleration of the glider. [1.5 marks]

e) acceleration of the glider at x = -0.013 m from its equilibrium position. [1.5 marks]

f) total mechanical energy of the glider at any point in its motion. [1.5 marks]

g) equation for the position as a function of time. Given that when at t = 0, the position of the glider was at maximum displacement. [1 mark]

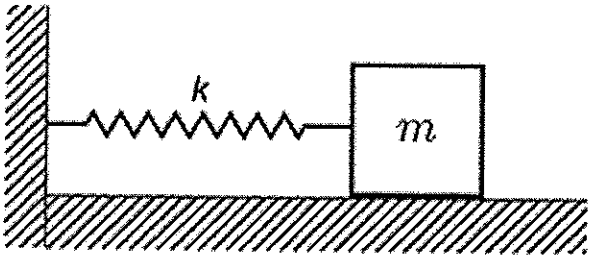

Figure 5(a)

APPENDIX I:

LIST OF PHYSICAL CONSTANTS

Electron mass,	m_e	=	9.11×10^{-31} kg
Proton mass,	m_p	=	1.67×10^{-27} kg
Neutron mass,	m_n	=	1.67×10^{-27} kg
Magnitude of the electron charge,	e	=	1.602×10^{-19} C
Universal gravitational constant,	G	=	6.67×10^{-11} N.m^2/kg^2
Universal gas constant,	R	=	8.314 J/mol.K
Hydrogen ground state,	E_0	=	13.6 eV
Boltzmann's constant,	k_B	=	1.38×10^{-23} J/K
Compton wavelength,	λ_c	=	2.426×10^{-12} m
Planck's constant,	h	=	6.63×10^{-34} J.s
		=	4.14×10^{-15} eV.s
Speed of light in vacuum,	c	=	3.0×10^8 m/s
Rydberg constant,	R_H	=	1.097×10^7 m^{-1}
Acceleration due to gravity of earth,	g	=	9.81 m/s^2
1unified atomic mass unit,	1 u	=	931.5 MeV/c^2
		=	1.66×10^{-27} kg
1 electron volt,	1 eV	=	1.60×10^{-19} J
Avogadro's number,	N_A	=	6.023×10^{23} mol^{-1}
Threshold of intensity of hearing,	I_0	=	1.0×10^{-12} W/m^2
Coulomb constant, $k = \frac{1}{4\pi\varepsilon_0}$		=	9.0×10^9 N.m^2/C^2
Permittivity of free space,	ε_0	=	8.85×10^{-12} C^2/N.m^{-2}
Permeability of free space,	μ_0	=	$4\pi \times 10^{-7}$ T.m/A
1 atmosphere pressure,	1 atm	=	1.0×10^5 N/m^2
			1.0×10^5 Pa
Earth: Mass,	M_E	=	5.97×10^{24} kg
Radius (mean),	R_E	=	6.38×10^3 km
Moon: Mass,	M_M	=	7.35×10^{22} kg
Radius (mean),	R_M	=	1.74×10^3 km
Sun: Mass,	M_S	=	1.99×10^{30} kg
Radius (mean),	R_S	=	6.96×10^5 km
Earth-Sun distance (mean),		=	149.6×10^6 km
Earth-Moon distance (mean),		=	384×10^3 km

APPENDIX II:

LIST OF FORMULAS IN MECHANICS

$y = kx^n$ $\frac{dy}{dx} = knx^{n-1}$	$\sin\theta = \frac{\text{opposite}}{\text{hypotenuse}}$	$\cos\theta = \frac{\text{adjacent}}{\text{hypotenuse}}$	$\tan\theta = \frac{\text{opposite}}{\text{adjacent}}$

$v = v_o + gt$ $\quad y - y_o = v_o t + \frac{1}{2}gt^2$ $\quad v^2 = v_o^2 + 2g(y - y_o)$

$y - y_o = \left(\frac{v_o + v}{2}\right)t$

$a_c = \frac{v^2}{r}$ $\quad F_g = G\frac{m_1 m_2}{r^2}$ $\quad U_g = -G\frac{m_1 m_2}{r}$ $\quad T^2 = K_s r^3$

$\tau = r \times F$ $\quad \sum\tau = \tau_{net} = I\alpha$ $\quad I = \sum mr^2$ $\quad v = r\omega$

$L = r \times p = I\omega$ $\quad K = \frac{1}{2}I\omega^2$

$T_s = 2\pi\sqrt{\frac{m}{k}}$ $\quad T_p = 2\pi\sqrt{\frac{l}{g}}$ $\quad T = \frac{2\pi}{\omega} = \frac{1}{f}$

$x = A\cos\omega t$ $\quad x = A\sin\omega t$

$v = -\omega A\sin\omega t$ $\quad v = \omega A\cos\omega t$

$a = -\omega^2 A\cos\omega t$ $\quad a = -\omega^2 A\sin\omega t$

$v = \frac{\Delta x}{\Delta t}$ $\quad a = \frac{\Delta v}{\Delta t}$

$v = v_o + at$ $\quad x - x_o = v_o t + \frac{1}{2}at^2$ $\quad v^2 = v_o^2 + 2a(x - x_o)$

$x - x_o = \left(\frac{v_o + v}{2}\right)t$

$W = mg$ $\quad \sum F = F_{net} = ma$ $\quad f_s \le \mu_S F_N$ $\quad f_k = \mu_K F_N$

$p = mv$ $\quad \sum F = \frac{\Delta p}{\Delta t}$

$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$ $\quad m_1u_1 + m_2u_2 = (m_1 + m_2)\,v$

$P = \frac{W}{t} = \frac{E}{t} = \frac{Fd}{t} = F\bar{v}$

$K = \frac{1}{2}mv^2$ $\quad PE_s = \frac{1}{2}kx^2$ $\quad F_s = -kx$ $\quad PE_G = mgy$